Appendix O

Economic Impact Analysis Methodology

APPENDIX O
ECONOMIC IMPACT ANALYSIS METHODOLOGY

INTRODUCTION

This appendix describes the methods and data that underlie the economic impact modeling analysis. Input-output models such as the Impact Analysis for Planning (IMPLAN) model, an economic impact analysis model, provide a quantitative representation of the production relationships between individual economic sectors. Thus, the economic modeling analysis uses information about physical production quantities and the prices and costs for goods and services. The inputs required to run the IMPLAN model are described in the following narrative and tables. The resulting estimates from the IMPLAN model, by alternative, are in **Chapter 4**, Environmental Consequences, **Section 4.20**, Social and Economic Impacts (Including Environmental Justice). The first portion of the following information describes general aspects of the IMPLAN model and how it was used to estimate economic impacts. The remaining sections provide additional detailed data used in the analysis for livestock grazing, recreation, and oil and gas.

THE IMPLAN MODEL

IMPLAN is a regional economic model that provides a mathematical accounting of the flow of money, goods, and services through a region's economy. The model provides estimates of how a specific economic activity translates into jobs and income for the region. It includes the ripple effect (also called the multiplier effect) of changes in economic sectors that may not be directly impacted by management actions, but are linked to industries that are directly impacted. In IMPLAN, these ripple effects are termed indirect impacts (for changes in industries that sell inputs to the industries that are directly impacted) and induced impacts (for changes in household spending as household income increases or decreases due to the changes in production).

This analysis used IMPLAN 2011; prior to running the model, cost and price data were converted to a consistent dollar year (2011) using sector-specific

adjustment factors from the IMPLAN model. The values in this appendix are expressed in year 2011 dollars.

The current IMPLAN model has 440 economic sectors, of which 309 are represented in the Socioeconomic Study Area counties. This analysis involved direct changes in economic activity for 27 IMPLAN economic sectors, as well as changes in all other related sectors due to the ripple effect. The IMPLAN production coefficients were modified to reflect the interaction of producing sectors in the Socioeconomic Study Areas. As a result, the calibrated model does a better job of generating multipliers and the subsequent impacts that reflect the interaction between and among the sectors in the Socioeconomic Study Area compared to a model using unadjusted national coefficients. Key variables used in the IMPLAN model were filled in using data specific to the Socioeconomic Study Area, including employment estimates, labor earnings, and total industry output.

The trade data available in the current version of IMPLAN (Version 3.0) make it possible to do multi-region analysis to track how an impact on any of the IMPLAN sectors in the study area affects production in any of the sectors in any other region of the US. For this analysis, this feature allowed the estimation of how an impact in the primary study area disperses into the secondary study area, and how these effects in the secondary study area create additional local effects in the primary study area. As a result, it was possible to estimate not only the jobs and income generation in the primary study area, but to also estimate how the economic activity in the primary study area affected jobs and income generation in the secondary study area.

LIVESTOCK GRAZING

Economic impacts from changes to livestock grazing are a function of the amount of forage available and the economic value of forage.

Forage availability was measured in Animal Unit Months (AUMs), with one AUM defined as the amount of forage needed to feed one cow, one horse, or five sheep for one month. Data on forage availability were obtained from BLM's Rangeland Administration System (BLM 2012) and from the Forest Service's INFRA range module (Forest Service 2013). Two types of AUM measures were used: Active AUMs and Billed AUMs. Active AUMs measure the amount of forage from land available for grazing. The Forest Service designates this measure "permitted" AUMs. Billed AUMs measure the amount of forage for which the BLM and Forest Service bill annually (i.e., the amount of forage that ranchers actually use, which is typically less than the amount of forage available). The Forest Service uses the designation "authorized" AUMs. Data for 2011 were used for active AUMs, except for active AUMs on the Humboldt-Toiyabe National Forest, for which 2012 data were used. Data for 2000 to 2011 were used to develop a 12-year average for billed AUMs.

Forage availability was estimated for all alternatives. Alternatives A, B, D, and E used the current data for active AUMs (obtained as explained above). Alternative C discounted the current data to remove 100 percent of active AUMs in GRSG habitat (all designated habitat [ADH]). Alternative F discounted the current data to remove 62.5 percent of active AUMs in ADH.[1] The analysis estimated 2,556,646 total active AUMs in the Socioeconomic Study Area, including 276,191 in the Humboldt-Toiyabe National Forest, 191,733 in the California BLM planning area, and 2,088,722 in the Nevada BLM planning area.[2] The analysis also estimated 2,223,515 active AUMs in ADH in the Socioeconomic Study Area (BLM 2013a), including 272,594 in the Humboldt-Toiyabe National Forest, 172,231 in the California BLM planning area, and 1,778,690 in the Nevada BLM planning area.[3] This information was used to calculate the total active AUMs that would be available for grazing under each alternative, including those in and not in ADH. The results of these calculations are presented in **Table O-1**, Estimated Active Annual Animal Unit Months by Alternative, below.

Table O-1
Estimated Active Annual Animal Unit Months by Alternative

Agency	Initial	Alternatives A, B, D, and E	Alternative C	Alternative F
		Active		
Forest Service	276,191	276,191	3,597	105,820
California BLM	191,733	191,733	19,502	84,089
Nevada BLM	2,088,722	2,088,722	310,032	977,041
Socioeconomic Study Area	2,556,646	2,556,646	333,131	1,166,949

Sources: Calculated based on data from BLM 2012, BLM 2013a, Forest Service 2013, and share of AUMs in ADH from **Chapter 4**, Environmental Consequences, **Section 4.9**, Livestock Grazing.

Table O-2, Estimated Billed Annual Animal Unit Months by Alternative, shows two scenarios for the number of billed AUMS under each alternative. For the high impact scenario, the analysis assumed that ranchers would choose to maintain a constant ratio of active to billed AUMs so any reduction to active AUMs would result in a proportional reduction to billed AUMs. Thus, the analysis applied the current ratio of active to billed AUMs to the calculated number of reduce active AUMS under each alternative to calculate the corresponding number of reduced billed AUMs under each alternative. For the

[1] Under Alternative F, 25 percent of the area in ADH must be rested each year. Of the remaining 75 percent, 50 percent must be set aside. Thus, the total area available for forage in ADH is reduced by 62.5 percent.
[2] The number of active AUMs listed for the Humboldt-Toiyabe National Forest represents the number of active AUMs within the National Forest and within the Socioeconomic Study Area, not all active AUMS in the National Forest.
[3] Because permitted AUMs include active and suspended AUMs (in BLM terminology), this comparison of total active AUMs with ADH permitted AUMs may overestimate the loss of AUMs under Alternative C.

low impact scenario, the analysis assumed that ranchers would continue to use as many of the initial billed AUMs as possible. If active AUMs were not reduced beyond the initial amount of billed AUMs, ranchers would continue to use the initial billed AUMs, resulting in no impact. If active AUMs were reduced beyond the initial amount of billed AUMs, ranchers would use all of the reduced active AUMs. Thus, when the number of reduced active AUMs was less than number of the initial billed AUMs, the analysis used the number of reduced active AUMs as the number of reduced billed AUMs under each alternative. Otherwise, the analysis assumed no change in the number of billed AUMs.

Table O-2
Estimated Billed Annual Animal Unit Months by Alternative

Agency	Initial	Alternatives A, B, D, and E	Alternative C	Alternative F
High Impact Scenario				
Forest Service	234,662	234,662	3,056	89,908
California BLM	119,729	119,729	12,178	52,510
Nevada BLM	1,228,727	1,228,727	182,382	574,761
Socioeconomic Study Area	1,583,118	1,583,118	197,616	717,179
Low Impact Scenario				
Forest Service	234,662	234,662	3,597	105,820
California BLM	119,729	119,729	19,502	84,089
Nevada BLM	1,228,727	1,228,727	310,032	977,041
Socioeconomic Study Area	1,583,118	1,583,118	333,131	1,166,949

Sources: Calculated based on data from BLM 2012, BLM 2013a, Forest Service 2013, and **Chapter 4**, Environmental Consequences, **Section 4.9**, Livestock Grazing.

Table O-3, Estimated Reduction in Annual Animal Unit Months by Alternative and Livestock Type, shows the two scenarios for resulting AUM reductions, calculated as the difference between the initial billed AUMs and the reduced billed AUMs under each alternative. AUMs are distinguished between those allocated to sheep, and those allocated to cattle and other animals, to allow different valuation of forage, as explained further below.

The economic value of forage is estimated based on the value of production associated with the forage. Values for cattle and sheep are estimated separately, with the value of forage for other animals considered equivalent to the value for cattle. Due to price fluctuations, average per-AUM values for cattle and sheep are based on the 2002 to 2011 average value of production estimates from the (US Department of Agriculture, Economic Research Service 2012). The value for cattle is $50.37 per AUM, and the value for sheep is $57.20 per AUM in the Socioeconomic Study Area (in 2010 dollars). Including indirect and induced impacts, the value of one AUM in the Socioeconomic Study Area for cattle is

Table O-3
Estimated Reduction in Annual Animal Unit Months by Alternative and Livestock Type

Agency	High Impact Scenario			Low Impact Scenario		
	Alternatives A, B, D, E	Alternative C	Alternative F	Alternatives A, B, D, E	Alternative C	Alternative F
Total						
Forest Service	0	-231,606	-144,754	0	-231,065	-128,842
California BLM	0	-107,551	-67,219	0	-100,227	-35,640
Nevada BLM	0	-1,046,345	-653,966	0	-918,695	-251,686
Socioeconomic Study Area	0	-1,385,502	-865,939	0	-1,249,987	-416,169
Cattle and Other						
Forest Service	0	-192,156	-120,098	0	-191,708	-106,897
California BLM	0	-103,300	-64,563	0	-96,266	-34,232
Nevada BLM	0	-965,969	-603,731	0	-848,124	-232,353
Socioeconomic Study Area	0	-1,261,426	-788,391	0	-1,136,098	-373,481
Sheep						
Forest Service	0	-39,450	-24,656	0	-39,357	-21,946
California BLM	0	-4,251	-2,657	0	-3,961	-1,409
Nevada BLM	0	-80,376	-50,235	0	-70,571	-19,334
Socioeconomic Study Area	0	-124,076	-77,548	0	-113,889	-42,688

Sources: Calculated based on data from BLM 2012, BLM 2013a, and Forest Service 2013.

$101.14 and for sheep is $124.91 (in 2010 dollars). **Table O-4**, Assumptions for Analysis of Impacts on Output for Livestock Grazing, shows the economic impact assumptions for cattle and sheep. The direct economic impact is the estimated change in livestock output per AUM; IMPLAN generates the indirect and induced impacts.

Table O-4
Assumptions for Analysis of Impacts on Output for Livestock Grazing

Economic Impact	Cattle	Sheep
Direct Economic Impact ($/AUM)	$50.37	$57.20
Indirect Economic Impact ($/AUM)[1]	$42.50	$56.27
Induced Economic Impact ($/AUM)[2]	$8.26	$11.45
Total Economic Impact ($/AUM)	$101.14	$124.91
Multiplier (Total Impact/Direct Impact)	2.01	2.18

Note: All dollar values are in 2010 dollars.
[1]Indirect impacts reflect increased demand in sectors that directly or indirectly provide supplies to the livestock industry.
[2]Induced impacts reflect increased demand in the consumer and government sectors.

Table O-5, Assumptions for Analysis of Employment Impacts for Livestock Grazing, provides a summary of the employment impacts that would result, according to IMPLAN, based on unit changes in livestock AUMs.

Table O-5
Assumptions for Analysis of Employment Impacts for Livestock Grazing

Employment Impact	Cattle	Sheep
Direct Employment (Jobs/1,000 AUMs)	0.000559	0.000980
Indirect Employment (Jobs/1,000 AUMs)	0.000435	0.000708
Induced Employment (Jobs/1,000 AUMs)	0.000072	0.000099
Total Employment (Jobs/1,000 AUMs)	0.001065	0.001787
Multiplier (Total Impact/Direct Impact)	1.91	1.82
Average Earnings per Job (2010 dollars)	$35,239	$21,672

Note: Direct, indirect, and induced employment impacts and average earnings per job are calculated using IMPLAN.

GEOTHERMAL EXPLORATION AND DEVELOPMENT

Economic impacts from geothermal exploration and development are a function of construction and operation expenditures for geothermal electricity development, including drilling wells (exploratory, production and injection), constructing power plants, and operating facilities. In the Reasonably Foreseeable Development scenario for geothermal development, BLM developed a scenario to serve as a basis for analyzing impacts resulting from future leasing and development of federal geothermal resources within the decision area over the next 20 years.

To estimate economic activity associated with geothermal development, BLM first used the National Renewable Energy Laboratory's Jobs and Economic Development Impact (JEDI) model (NREL, 2012) to determine approximate capital and operating costs associated with a representative power plant. The assumptions used a 15 MW nameplate capacity and typical conditions for the planning area: a resource at about 310 degrees Fahrenheit at a depth of 5,500 feet; binary cycle; and two production wells per injection well (BLM 2013c). BLM used standard assumptions from the National Renewable Energy Laboratory for the local share of construction and operating expenses that would be spent within the state of Nevada, as an approximation for the study area (local spending assumptions were available at the state level but not the county level). BLM then used IMPLAN, calibrated to the specific region of the socioeconomic study area, to calculate indirect and induced impacts associated with a given direct expenditure. **Table O-6**, Assumptions for Analysis of Impacts on Output for Geothermal Exploration and Development, shows the resulting assumptions for construction and operation of an individual power plant.

Table O-6
Assumptions for Analysis of Impacts on Output for Geothermal Exploration and Development

Economic Impact (millions of 2010 dollars)	Traditional Hydrothermal Plant	Enhanced Geothermal Systems Plant
Construction		
Direct Economic Impact[1]	$42.4	$42.7
Indirect Economic Impact[2]	$3.7	$4.0
Induced Economic Impact[3]	$9.3	$9.9
Total Economic Impact	$55.4	$56.6
Multiplier (total impact/direct impact)	1.31	1.33
Operation		
Direct Economic Impact[1]	$1.3	$1.2
Indirect Economic Impact[2]	$0.0	$0.0
Induced Economic Impact[3]	$0.7	$0.6
Total Economic Impact	$2.0	$1.8
Multiplier (total impact/direct impact)	1.56	1.56

Notes: Details may not add to total due to rounding.
[1]Direct economic impact is the average expenditure per plant, assuming an average nameplate capacity of 15 MW.
[2]Indirect impacts from IMPLAN reflect increased demand in sectors that directly or indirectly provide support for the geothermal exploration and development industry.
[3]Induced impacts from IMPLAN reflect increased demand in the consumer and government sectors (e.g., employee wages).

Table O-7, Assumptions for Employment Impact Analysis for Geothermal Exploration and Development Activities, provides a summary of employment impacts according to IMPLAN results, based on construction and operation of each type of power plant.

OIL AND GAS

The economic impact of oil and gas reflects drilling, completion, and production activities. The number of wells expected to be developed, and how BLM developed its assumptions, is discussed in **Chapter 4**, Environmental Consequences, **Section 4.12**, Minerals – Fluid. BLM assumed a completion rate ranging from 10 percent to 75 percent, as well as production per well completed, using assumptions appropriate to the area. **Table O-8**, Oil and Gas Wells and Production, provides the resulting estimated numbers of wells and production that were used for the economic analysis.

The costs of drilling and completing wells and producing oil and gas also are relevant for the economic impact analysis. Starting with the estimate of $3.25 million for drilling and completion of one well (BLM 2013b), the estimate was adjusted from 2012 to 2010 dollars using price indices from IMPLAN, then the percentage of local spending and breakouts into drilling and completion costs

Table O-7
Assumptions for Employment Impact Analysis for Geothermal Exploration and Development Activities

Employment Impact (number of jobs per plant)	Traditional Hydrothermal Plant	Enhanced Geothermal Systems Plant
Construction		
Direct Employment	246.1	272.5
Indirect Employment	31.7	33.3
Induced Employment	77.6	82.8
Total Employment	355.4	388.6
Multiplier (Total Impact/Direct Impact)	1.44	1.43
Average Earnings per Job (2010 dollars)	$57,107	$62,996
Operation		
Direct Employment	10.0	9.0
Indirect Employment	0.0	0.0
Induced Employment	5.9	5.4
Total Employment	15.9	14.4
Multiplier (Total Impact/Direct Impact)	1.59	1.60
Average Earnings per Job (2011 dollars)	$94,220	$95,237

Note: Direct, indirect, and induced employment impact and average earnings per job are calculated using IMPLAN, as described in the text.

Table O-8
Oil and Gas Wells and Production

Area	Wells drilled on new leases	Wells completed on new leases	Wells drilled on existing leases	Wells completed on existing leases	Production (barrels of oil per completed well)
Great Basin Core	10	7.5	50	37.5	1,000,000
NW-Interior NV	0	0	1	0.1	200,000
Warm Springs	1	0.6	3	1.8	200,000
Quinn Range NV	20	10	20	10	1,000,000

Source: BLM (2013b). The BLM's analysis also indicates that there would be some gas production, which would be used on location or vented to the atmosphere (BLM 2013b). Because the gas may simply be vented without being used productively, the economic analysis does not factor in the potential to sell it.

were estimated based on IMPLAN factors and costs for wells in other parts of the Great Basin. The price for oil from Utah was used since the Energy Information Administration does not provide a price for Nevada; the price and cost per barrel of oil were based on EIA (2010) and EIA (2013). IMPLAN was then used to generate output, employment, and earnings multipliers per unit. Impacts were estimated by multiplying per-unit impact estimates by the number

of wells drilled and completed, and number of barrels of oil produced. **Table O-9**, Assumptions for Analysis of Output, Earnings, and Employment for Oil and Gas, provides a summary of the per-unit values used for output, employment, and earnings.

Table O-9
Assumptions for Analysis of Output, Earnings, and Employment for Oil and Gas

Economic Impact[1]	Drilling (per well)	Completion (per well)	Production (per MBO)
Direct output	$1,357,100	$994,335	$79,724
Indirect output	$257,013	$180,167	$10,937
Induced output	$478,418	$381,268	$5,373
Total output	$2,092,531	$1,555,770	$96,034
Multiplier[2]	1.54	1.56	1.20
Direct earnings	$717,311	$580,892	$4,405
Indirect earnings	$102,923	$73,455	$4,761
Induced earnings	$161,781	$128,959	$1,818
Total earnings	$982,015	$783,306	$10,984
Multiplier	1.37	1.35	2.49
Direct employment	8.1	6.7	0.060660
Indirect employment	2.0	1.5	0.074855
Induced employment	4.0	3.2	0.045061
Total employment	14.1	11.4	0.180576
Multiplier	1.74	1.70	2.98
Average earnings per job	$69,646	$68,711	$60,825

Sources: BLM 2013b, EIA 2010, EIA 2013, and the IMPLAN model, as described in the text.
MBO = thousands of barrels of oil
1. All dollar figures are in 2010 dollars.
2. Multiplier is calculated as total impact divided by direct impact.

REFERENCES

BLM (United States Department of the Interior, Bureau of Land Management). 2012. Data from BLM Rangeland Administration System.

_____. 2013a. Grazing Impacts. Data provided in personal communication from Mike Tietmeyer, BLM, Nevada State Office. May and June 2013.

_____. 2013b. Oil and Gas Data. Data provided in personal communication from John Menghini, Petroleum Engineer, BLM, May and June 2013.

_____. 2013c. Geothermal RFD. Personal communication via Sheila Mallory, BLM, Nevada State Office. June 2013.

NREL (National Renewable Energy Laboratory). 2012. Jobs and Economic Development Impact Geothermal Model, Release GT08.02.12. Internet Web site: http://www.nrel.gov/analysis/jedi/download.html. Accessed in May 2013.

US Department of Agriculture, Economic Research Service. 2012. Commodity Costs and Returns. Internet Web site: http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx. Accessed in August 2012.

EIA (Energy Information Administration). 2010. 2009 Oil & Gas Lease Equipment & Operating Costs, Oil Production for the Rocky Mountain Region. Internet Web site: http://www.eia.gov/pub/oil_gas/natural_gas/data_publications/cost_indices_equipment_production/current/coststudy.html. Accessed in June 2013.

_____. 2013. Utah Crude Oil First Purchase Price (Dollars per Barrel), converted to 2010 dollars. Internet Web site: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=f004049__3&f=m. Accessed in June 2013.

US Forest Service (United States Department of Agriculture, Forest Service). 2013. Humboldt-Toiyabe National Forest Permitted and Authorized AUMs. Data provided in personal communication from Chris Miller, US Forest Service, May and June 2013.